
Collector lifetime measurements

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EUV Sources: debris metrology and samples

LPP (Laser Produced Plasma)

Setup: witness plates, analytics after exposure

Samples : multilayer witness plates

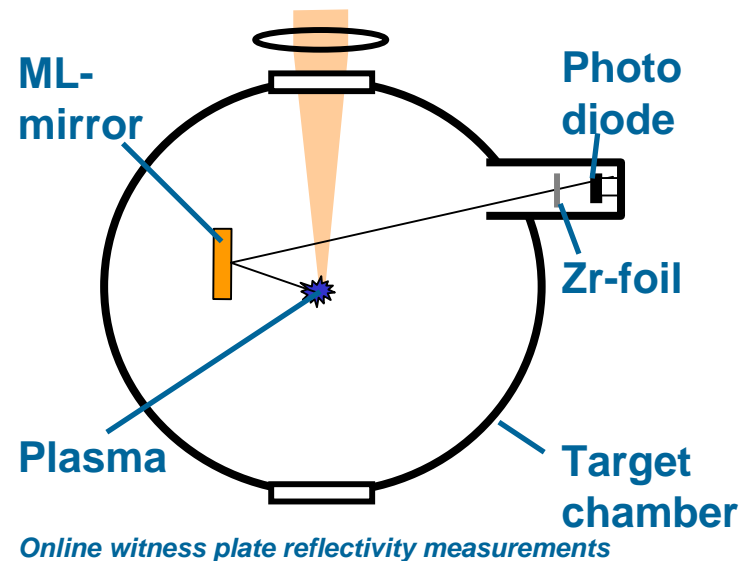
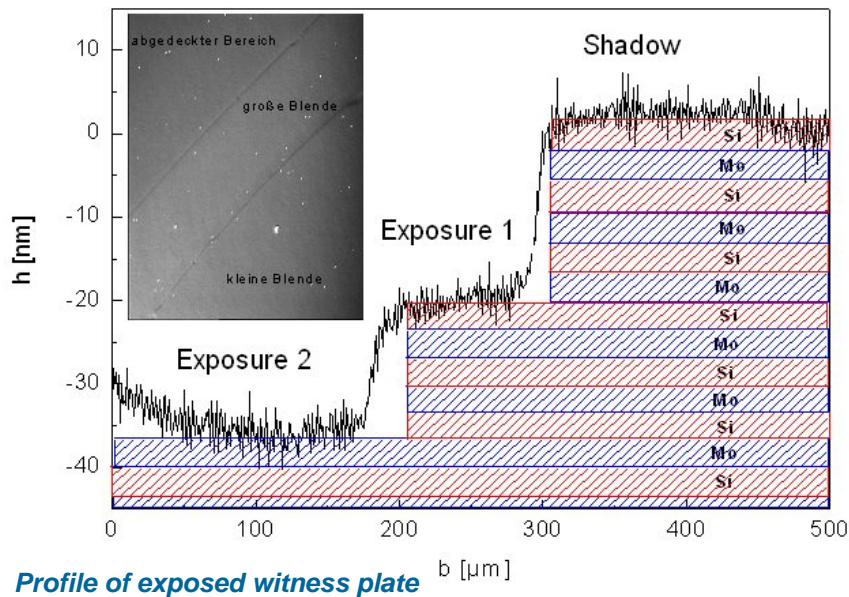
GDPP (Gas Discharge Produced Plasma)

Setup: Layer sensor, reflectivity measurements,
analytics after exposure

Samples: grazing incidence mirror samples

LPP EUV Sources: EUV-optics lifetime data

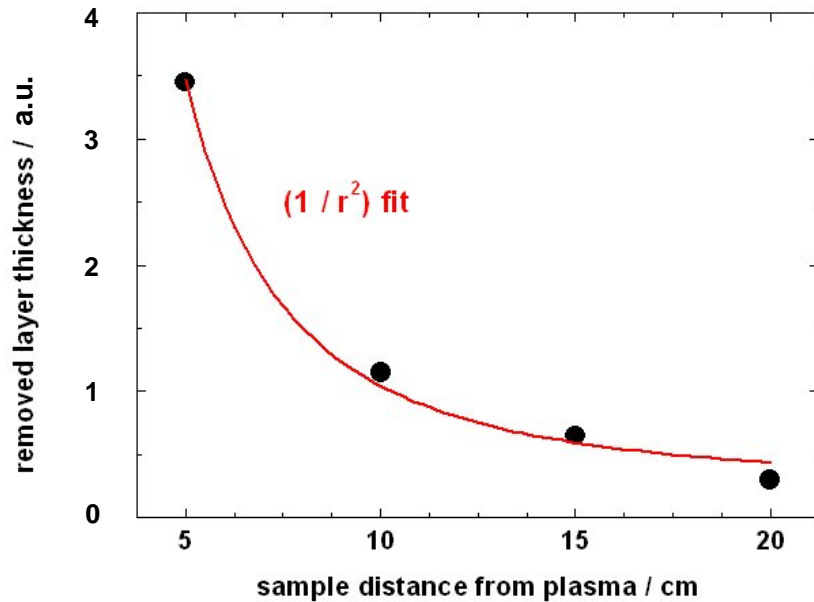
Witness plate reflectivity is monitored during exposure / plate is analyzed afterwards



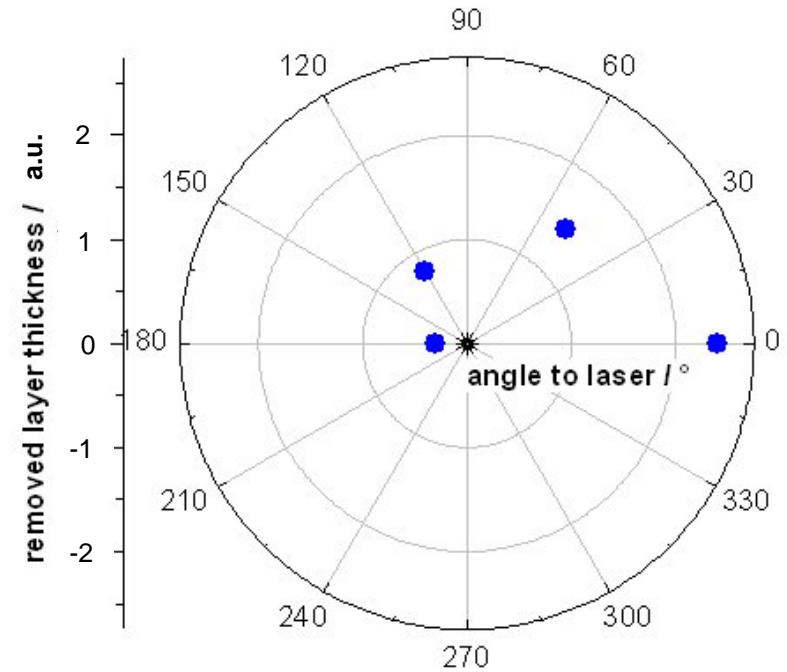
Lifetime with an EUV-inband energy of 0.5 mJ / pulse:

- dominating effect is erosion
- 5×10^6 pulses without debris mitigation (10% reflectivity loss)
- with debris mitigation to 10^7 pulses no erosion measured

LPP EUV Sources: EUV-optics lifetime data



distance dependent erosion rate



angle dependent erosion rate

Witness plates were placed at different distances and angles:

- the erosion rate at optics-relevant distances scales $\propto 1/r^2$
- the strongest erosion is found in the laser direction

LPP EUV Sources: outlook

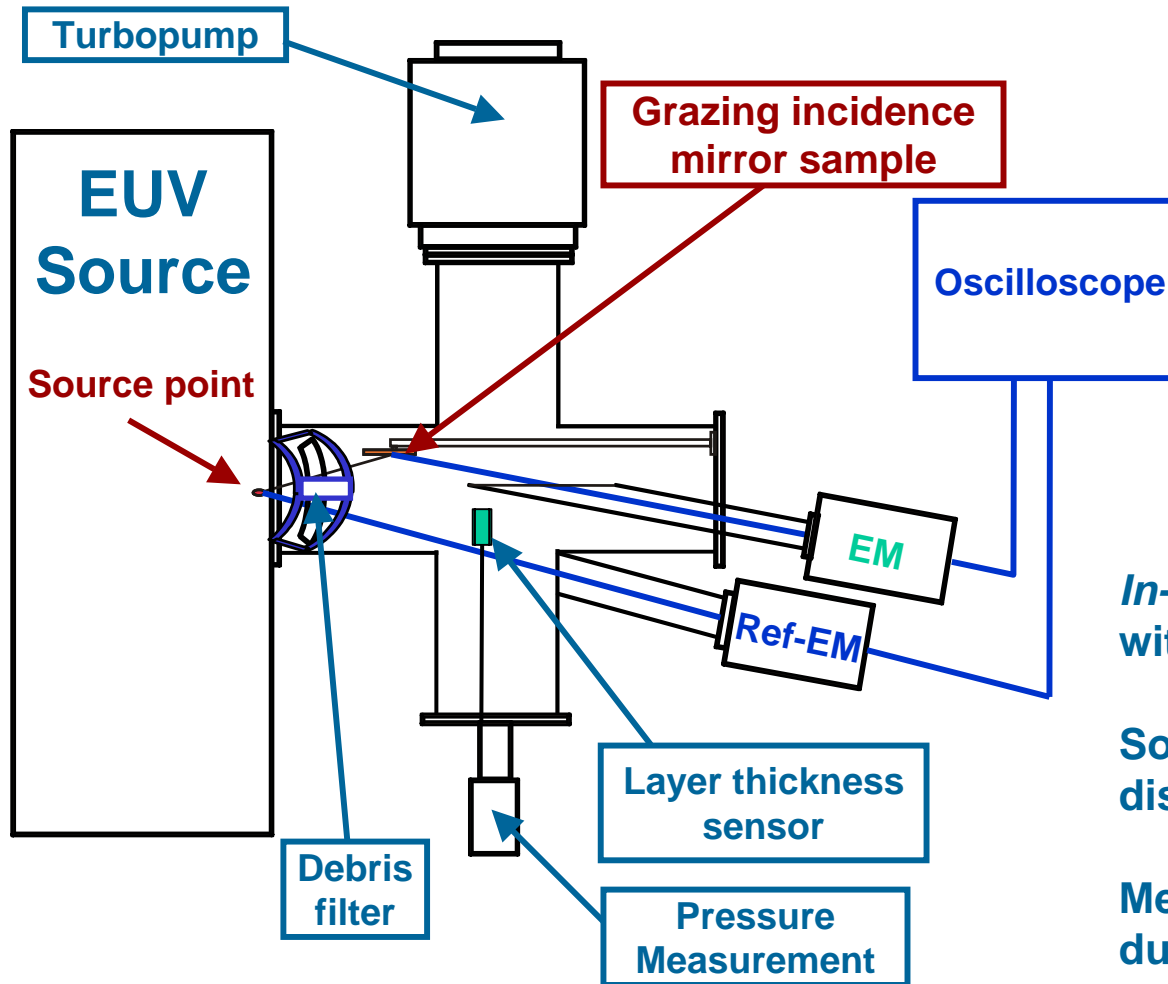
Optics lifetime / debris mitigation:

- **>10⁹ at 10 W 2 π EUV-inband power in Q2 / 2004**

EUV-collector implementation:

- **π -collector scheduled for Q3 / 2004**
- **Lifetime measurements**

GDPP EUV Source: debris and optics lifetime



Layer thickness sensor:

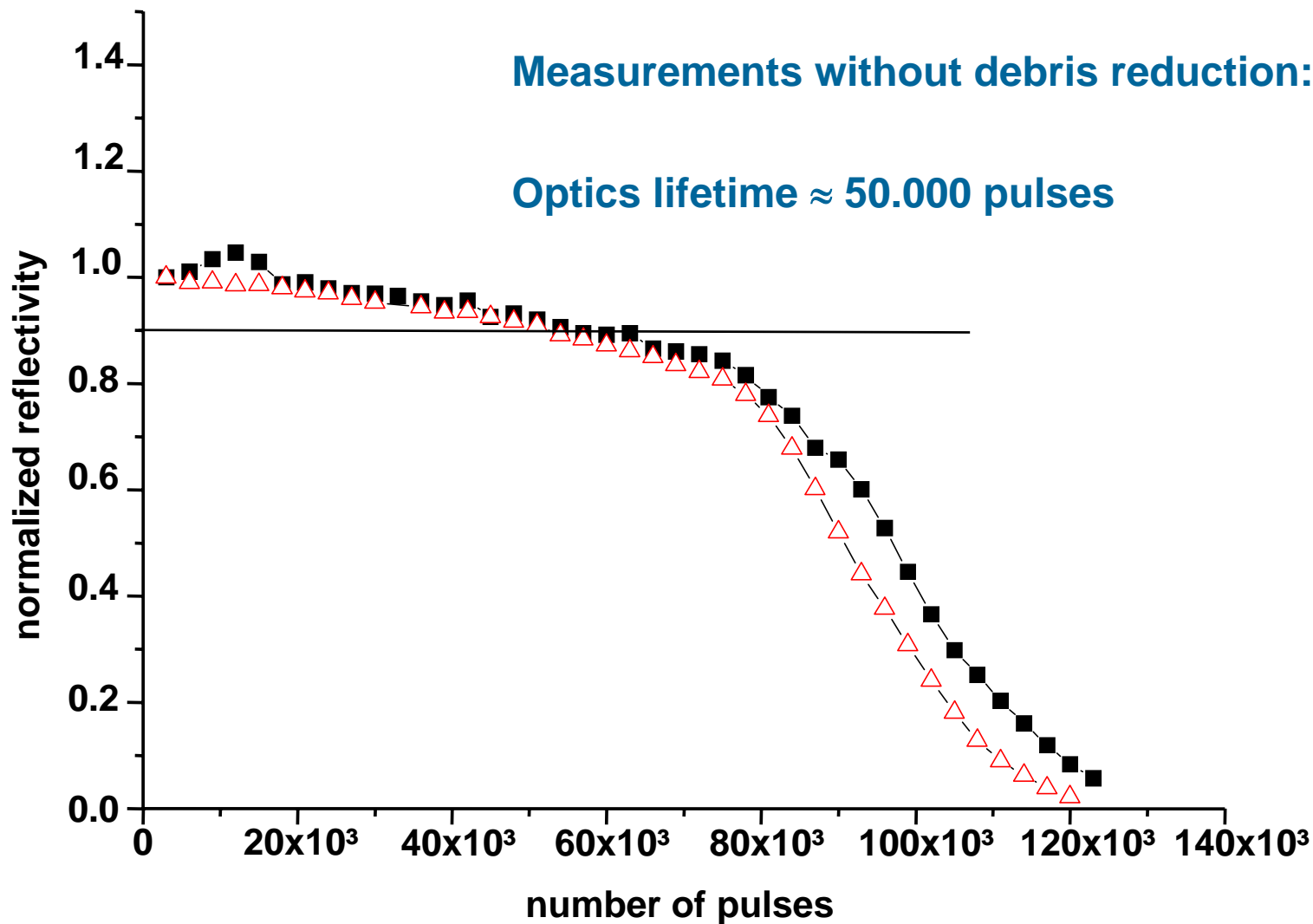
- Measures change in mass due to sputtering and/or deposition

In-situ reflectivity measurement with energy monitor (EM)

Source – mirror sample distance: 110 mm

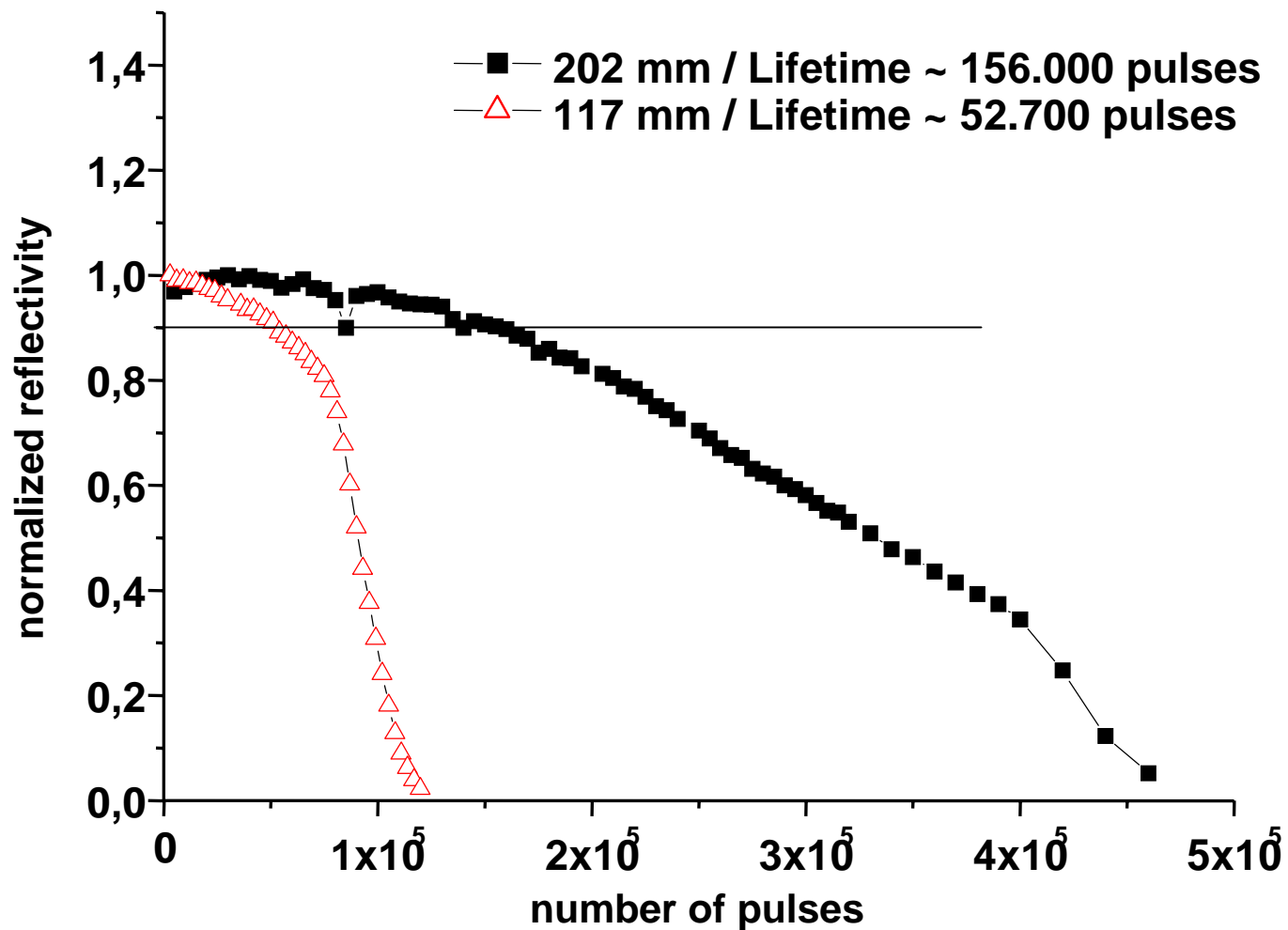
Measures change in reflectivity due to sputtering and/or deposition

GDPP EUV Source: lifetime of collector optics

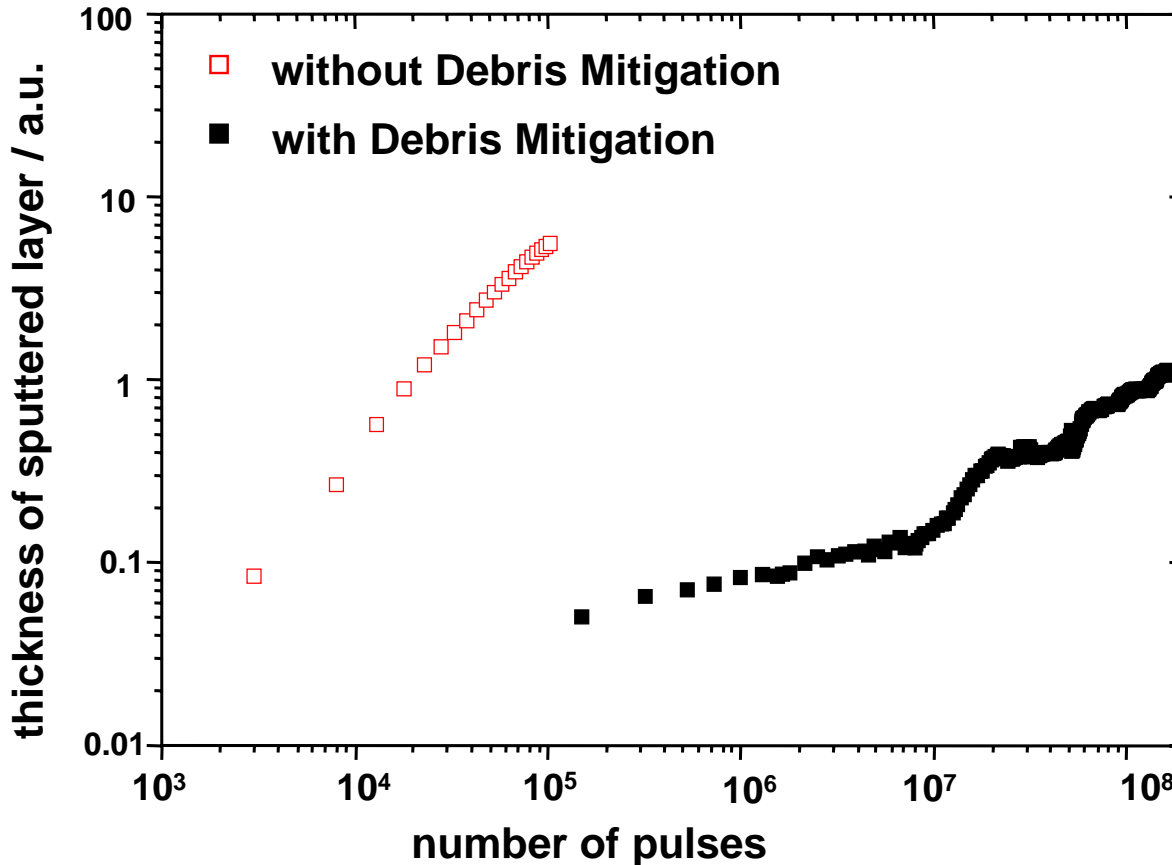


GDPP EUV Source: lifetime of collector optics

distance to source variation



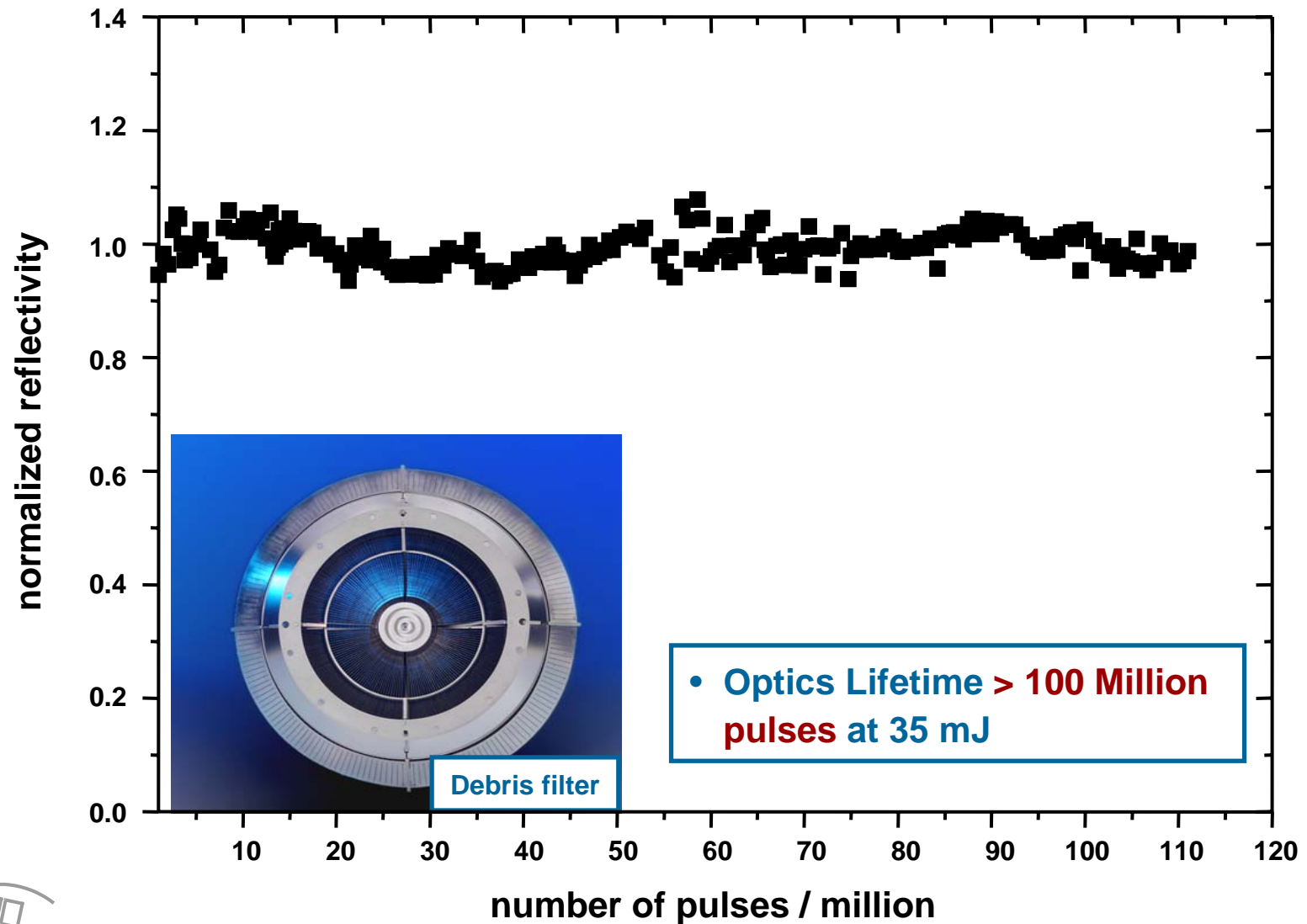
GDPP EUV Source: debris and source collector optics lifetime



Progress in debris filter arrangement and operation:

Suppression of sputtering by fast particles at surface of collector optics by approximately 5000 times

GDPP EUV Source: collector optics lifetime



GDPP EUV Sources: outlook

Design Phase:

Debris mitigation tool for high power Xe based EUV GDPP sources

Conception phase:

Debris mitigation tool for Sn based GDPP EUV sources

GDPP and LPP EUV Sources: summary

- **Debris / EUV-Photon: LPP \approx GDPP (modeling and measurements)**
- **GDPP: collector lifetime exceeds 10^8 pulses**
- **GDPP: debris suppression by 5×10^3 times**
- **LPP: collector lifetime $> 10^7$ demonstrated without erosion**

Thanks for your attention !!!

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**open positions in Jena & Göttingen
at
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or

visit our web-page at:

<http://www.xtremetec.de/index.htm>